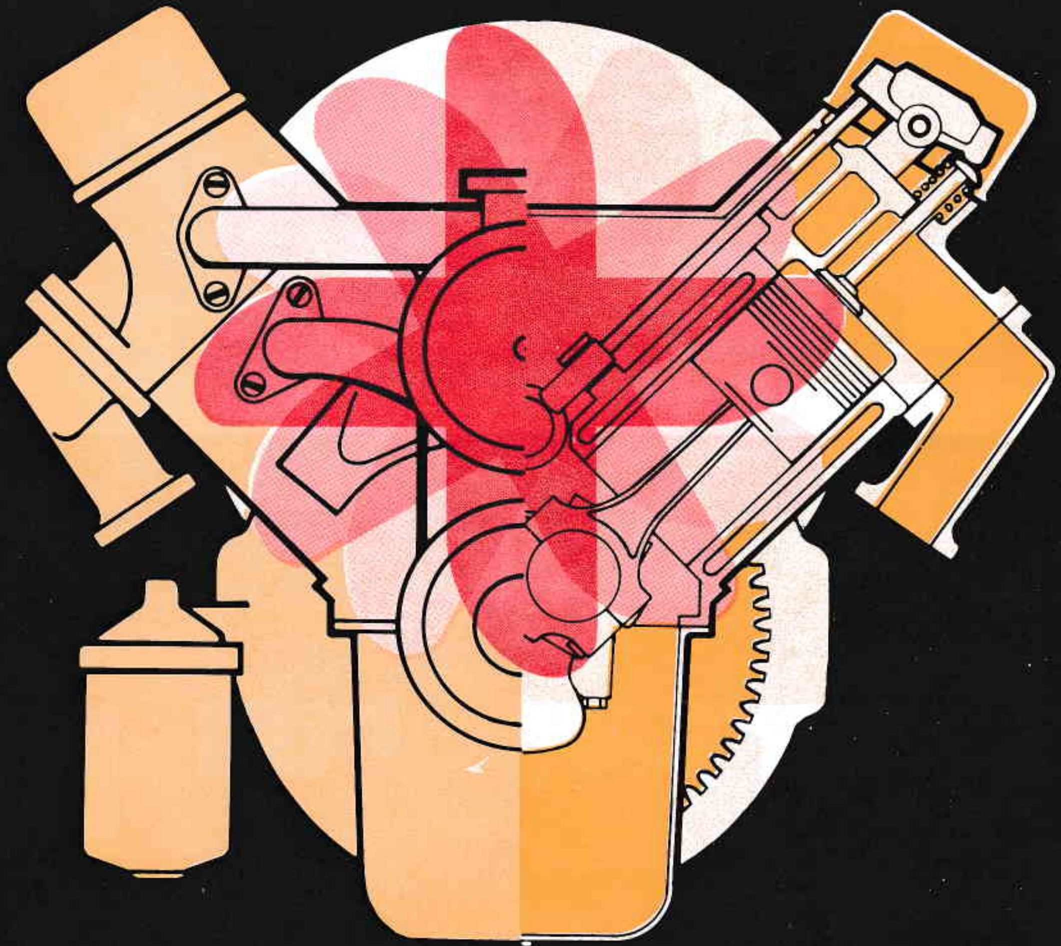
HOW AN AUTO ENGINE WORKS

an illustrated guide to THE VISIBLE V-8 ENGINE assembly kit



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Brooklyn High School of Automotive Trades

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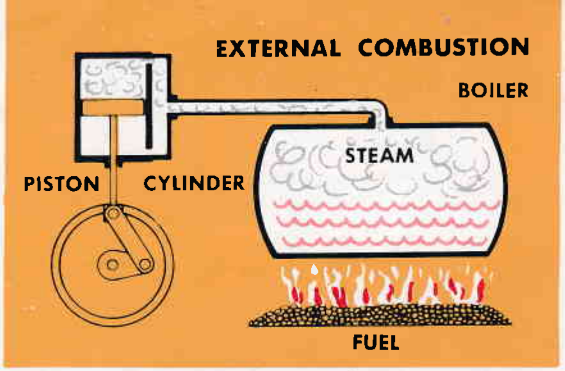
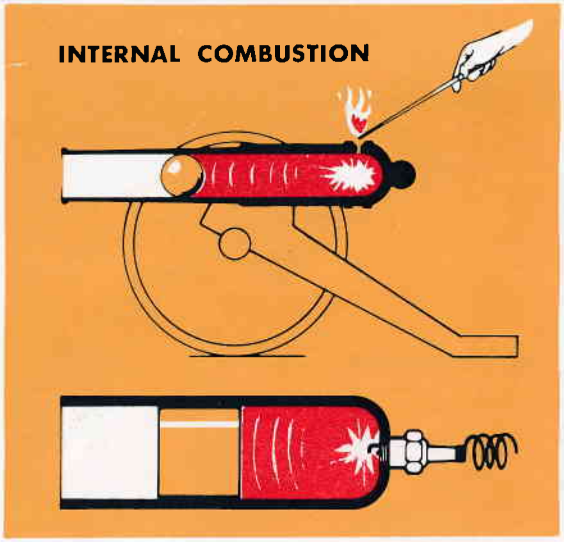
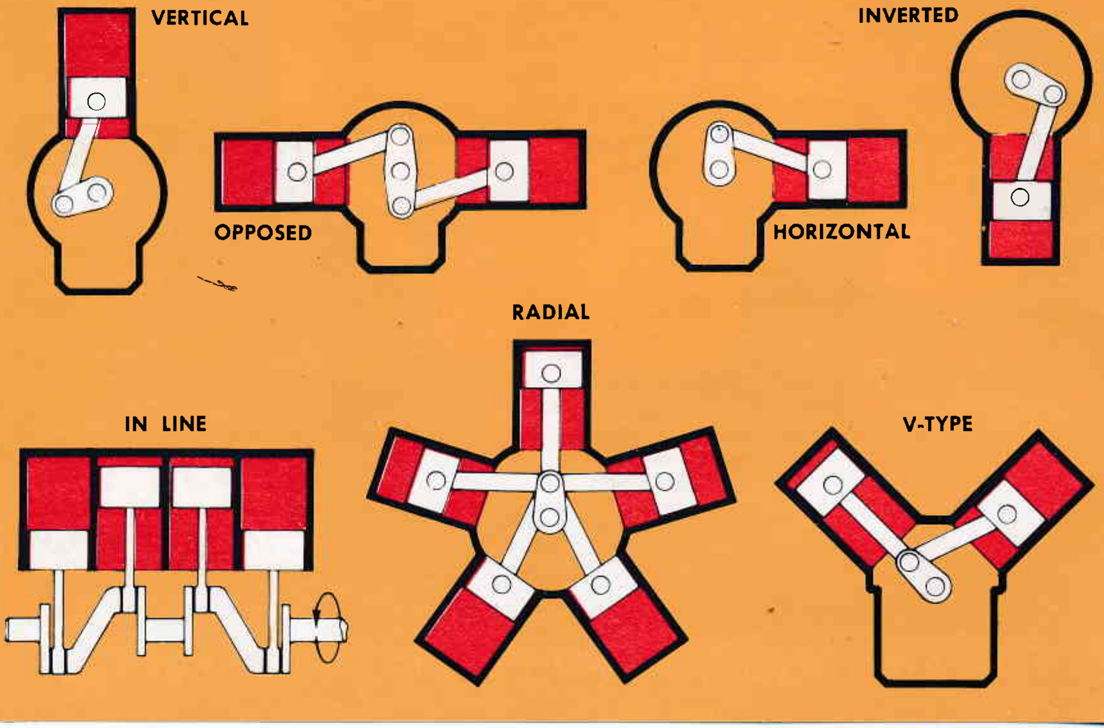


An engine is by definition *"any machine used for converting a physical force, such as heat, into mechanical power."* Heat can be used to generate steam to operate a steam engine. Such an engine is called an EXTERNAL COMBUSTION ENGINE because the fuel is burned outside of the engine.



When the fuel is burned inside the engine, the engine is called an INTERNAL COMBUSTION ENGINE. The fuel is burned inside a cylinder and the expansion of the gas created will push a piston in much the same way as the explosive force of gun powder in a gun barrel will push the bullet. It is this type engine with which we are concerned in this booklet.

Internal Combustion Engines vary considerably in scope and size, in the number of cylinders employed, their arrangement and grouping. Below are some typical cylinder arrangements.



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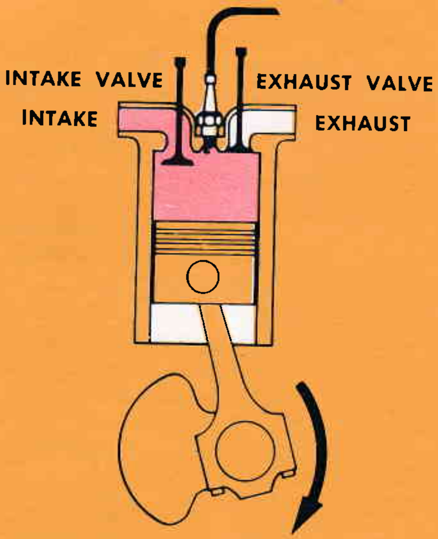
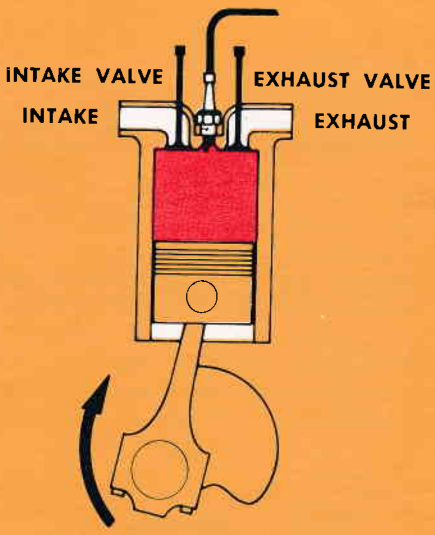


1. INTAKE

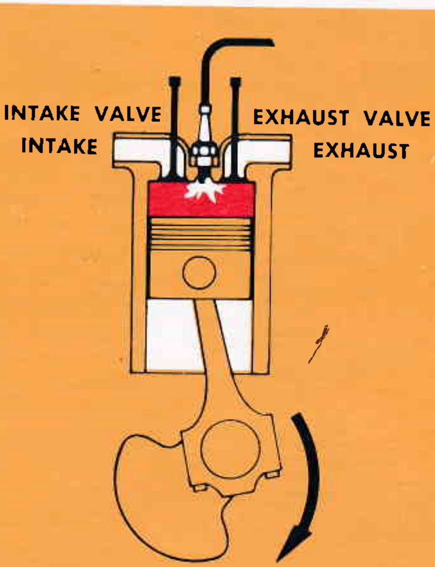
As the Piston moves downward in the Cylinder, it creates a vacuum. The vacuum draws the explosive mixture of gasoline and air from the Carburetor into the Intake Manifold then past the open Intake Valve into the Cylinder. The Exhaust Valve remains closed during the down stroke.



2. COMPRESSION

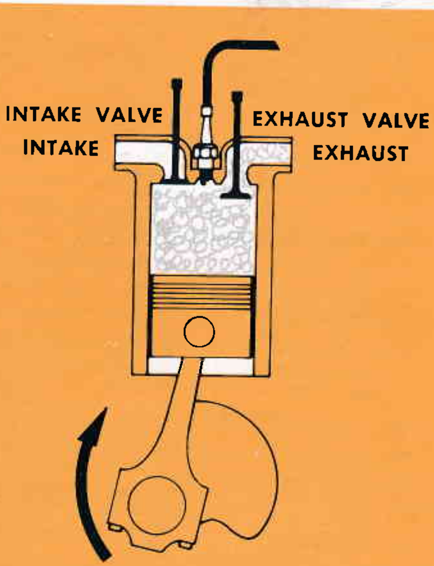
When the Piston gets to the end of the down stroke *(b.d.c. for bottom dead center)*, the Intake Valve closes. The Exhaust Valve remains closed and as the Piston moves upward, it compresses the mixture into a fraction of the space it originally occupied.

THE FOUR CYCLE ENGINE



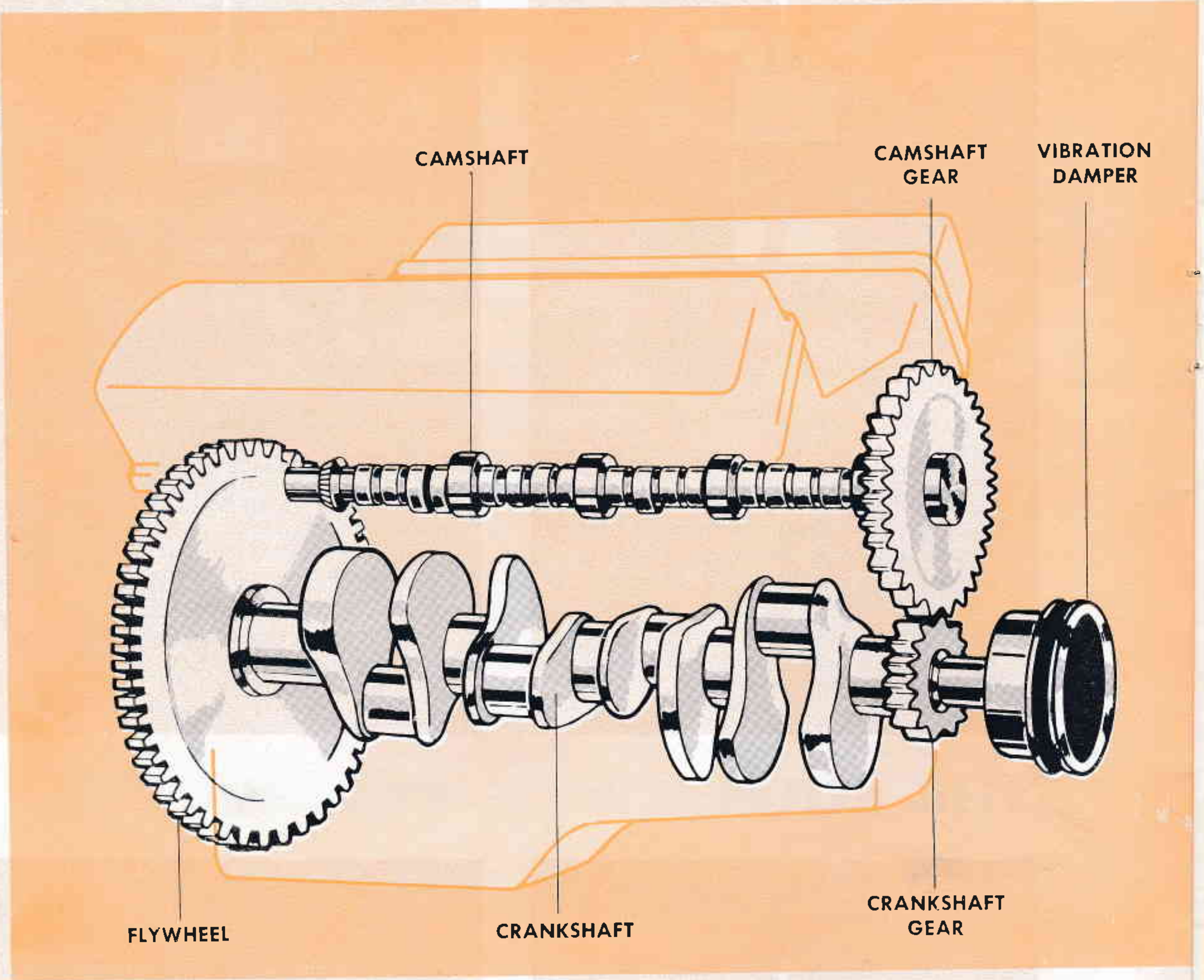
3. POWER

When the Piston reaches the peak of the upward stroke *(t.d.c. for top dead center)*, an electrical spark ignites the mixture which explodes with considerable force. The violently exploding gases force the piston downward, creating the power to turn the Crankshaft. Both Valves remain closed.



4. EXHAUST

When the Piston reaches *bottom dead center*, the Exhaust Valve opens. As the Piston moves upward, it forces the burned gas out of the Cylinder and into the Exhaust Manifold. When the Piston reaches *top dead center*, the Exhaust Valve closes, the Intake Valve opens and another cycle begins.



The CRANKSHAFT is a heavy steel forging (formed by heat and pressure) that carries offset portions known as Cranks which describe a circular motion when in operation. Between each pair of Cranks is a highly finished pin or Bearing Journal that carries the connecting rod bearing and piston assembly. As the piston and connecting rod assembly move in a vertical motion, the Crankshaft assembly, by means of the Cranks and Bearing Journals, converts this *vertical* motion to *rotary* or circular motion. It is this rotary motion that is delivered to the Flywheel and other driving components and eventually to the driving wheels. The Crankshaft is secured to the Crankcase by Main Bearing Caps which enclose additional highly finished pins known as the Main Bearing Journals.

The FLYWHEEL is mounted at the rear of the Crankshaft. Its mass provides the inertia to carry the Pistons through the unproductive strokes of the cycle. In addition, it helps the engine to run smoothly.

The VIBRATION DAMPER could be considered as another Flywheel at the other end of the Crankshaft. It serves, as the name indicates, to dampen the vibrations of the engine resulting from torsional stresses.

The CAMSHAFT is a straight shaft with a number of cams (one for each Valve), accurately designed and precisely timed to lift each Valve at exactly the correct instant of the beginning of the intake and exhaust strokes, and to hold each Valve open for the correct length of time required to fulfill each cycle in each Cylinder. At the front is the Camshaft Gear which is twice the size of the one on the Crankshaft; thus for every *two* revolutions of the Crankshaft we have *one* revolution of the Camshaft.

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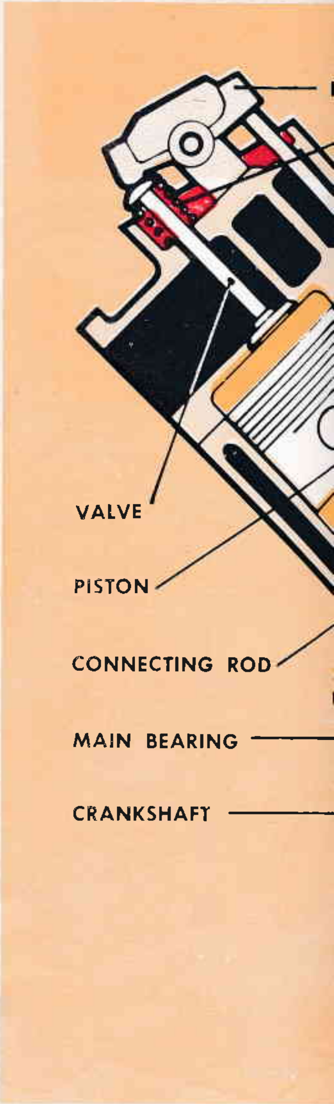
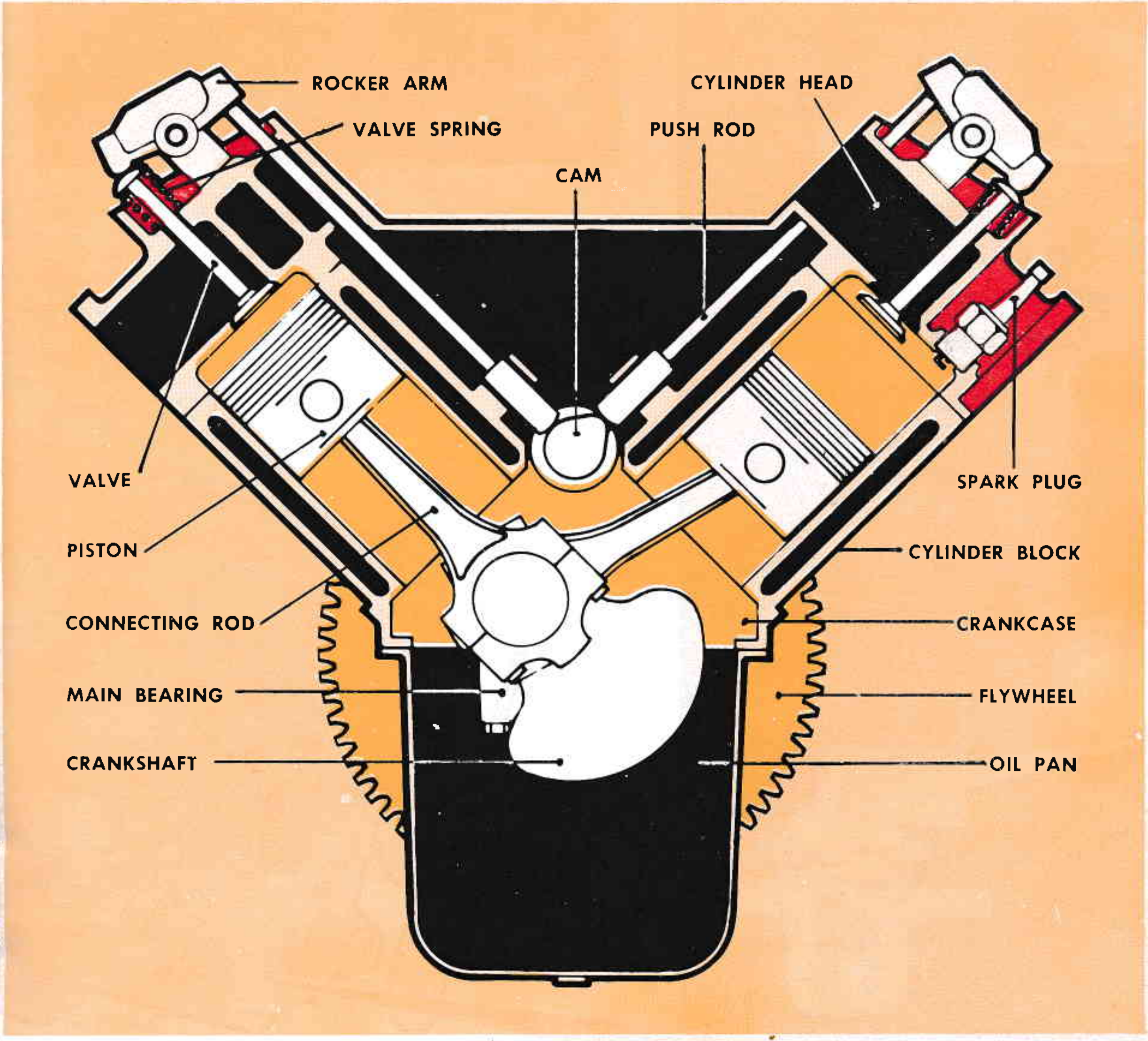


The CRANKCASE is the biggest part of the engine and, together with the OIL PAN at the bottom, it forms an oil-tight housing in which all the rotating parts of the engine operate.

The CYLINDER BLOCKS are usually part of the Crankcase; they house the Cylinders, the Pistons and the Connecting Rods.

The CYLINDER HEADS are bolted to the Cylinder Blocks. Since the water must circulate from the Blocks to the Heads, a series of matching holes are provided in the Blocks and the Heads, (see the Cooling System). The Heads house the Valves, their operating mechanisms and the Spark Plugs. To the Heads are bolted the Intake Manifold and the Exhaust Manifolds.

The VALVES have to perform under unusually difficult conditions. They are exposed to the extremely high temperatures generated in the combustion chambers, temperatures which often reach the melting point of iron. They must be leak-proof even under the tremendous pressures of the explosions and open and close as often as 2,000 times every minute.



THE FUEL SYSTEM

The Fuel System consists of t
FUEL PUMP, the CARBURE
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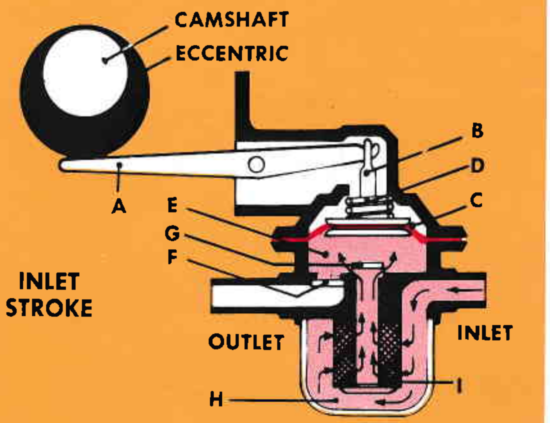
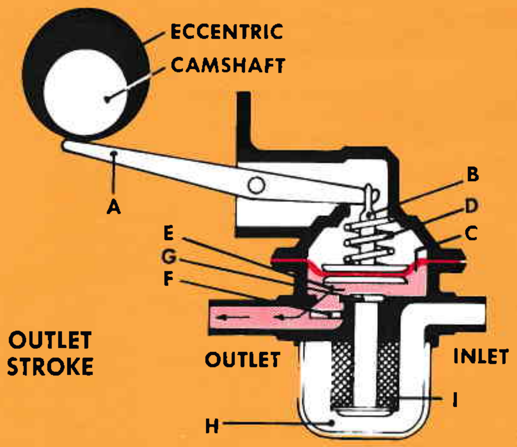
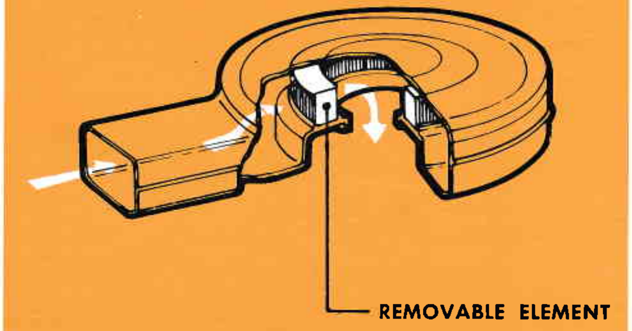
The FUEL PUMP is operated by an eccentric (off-center) cam at the front end of the Camshaft. As the Camshaft rotates, the eccentric cam actuates the Pump Rocker Arm (A) which pulls the Lever (B) and the flexible Diaphragm (C) upward against the pressure of the Diaphragm Spring (D), thus creating a vacuum in the Pump Chamber (E). This suction holds the Inlet Valve (G) open making the fuel flow from the Supply Tank into the Sediment Bowl (H). From the Sediment Bowl, the fuel passes through a Filter (I) where solid matter and water are trapped. Clean fuel enters through the open Inlet Valve (G) into the Pump Chamber (E).



On the return stroke, the Diaphragm (C) is forced down by the Spring (D), the Inlet Valve (G) closes and the Outlet Valve (F) is forced open allowing the fuel to flow through the outlet to the Carburetor.



The AIR CLEANER is designed to trap the dust particles in the air that rush to the Carburetor. This function is performed by a replaceable cellulose filter element inside the Air Cleaner. It also acts as a flame arrester and an air silencer.



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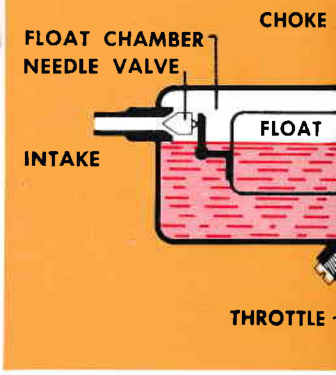
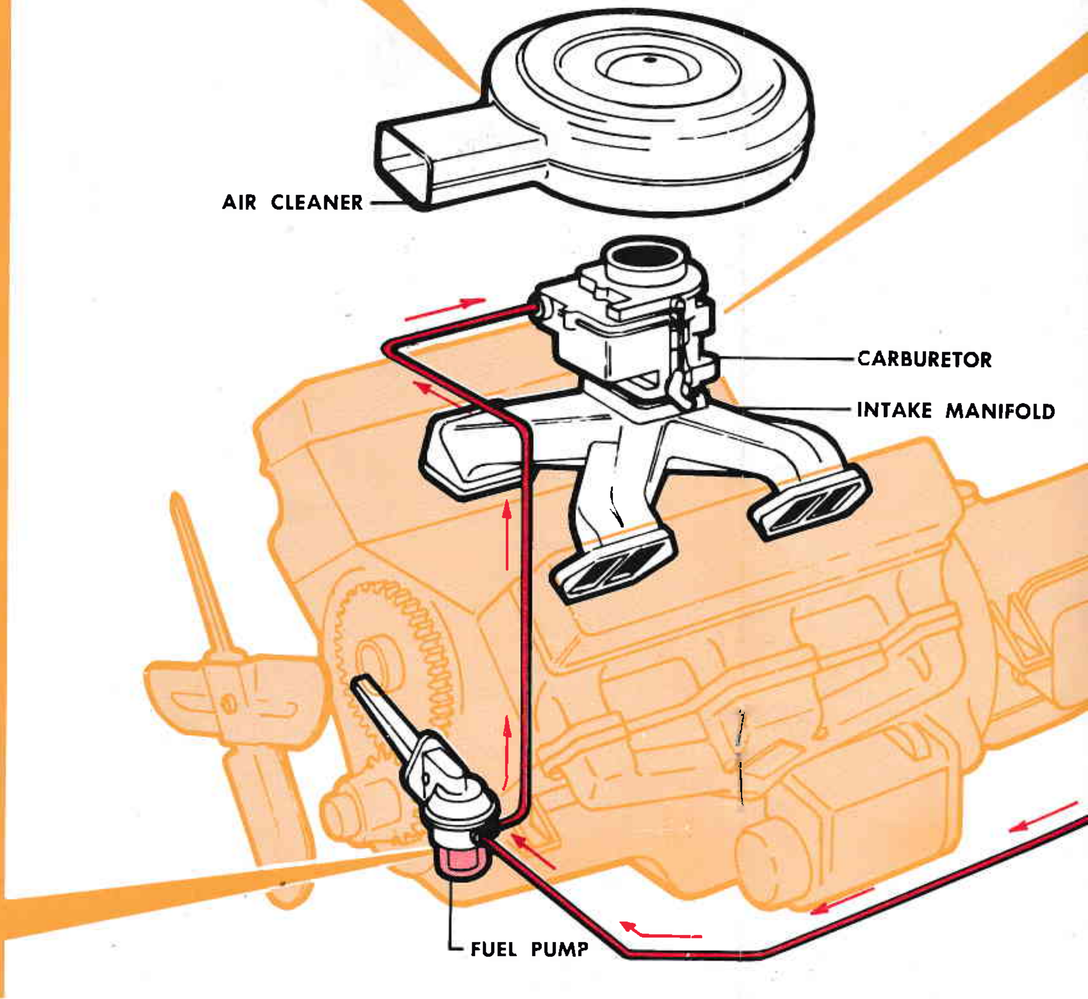
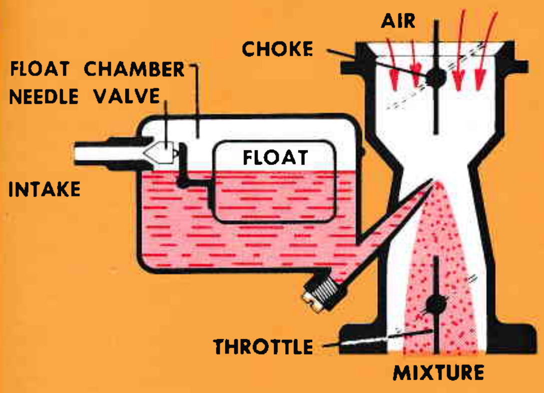




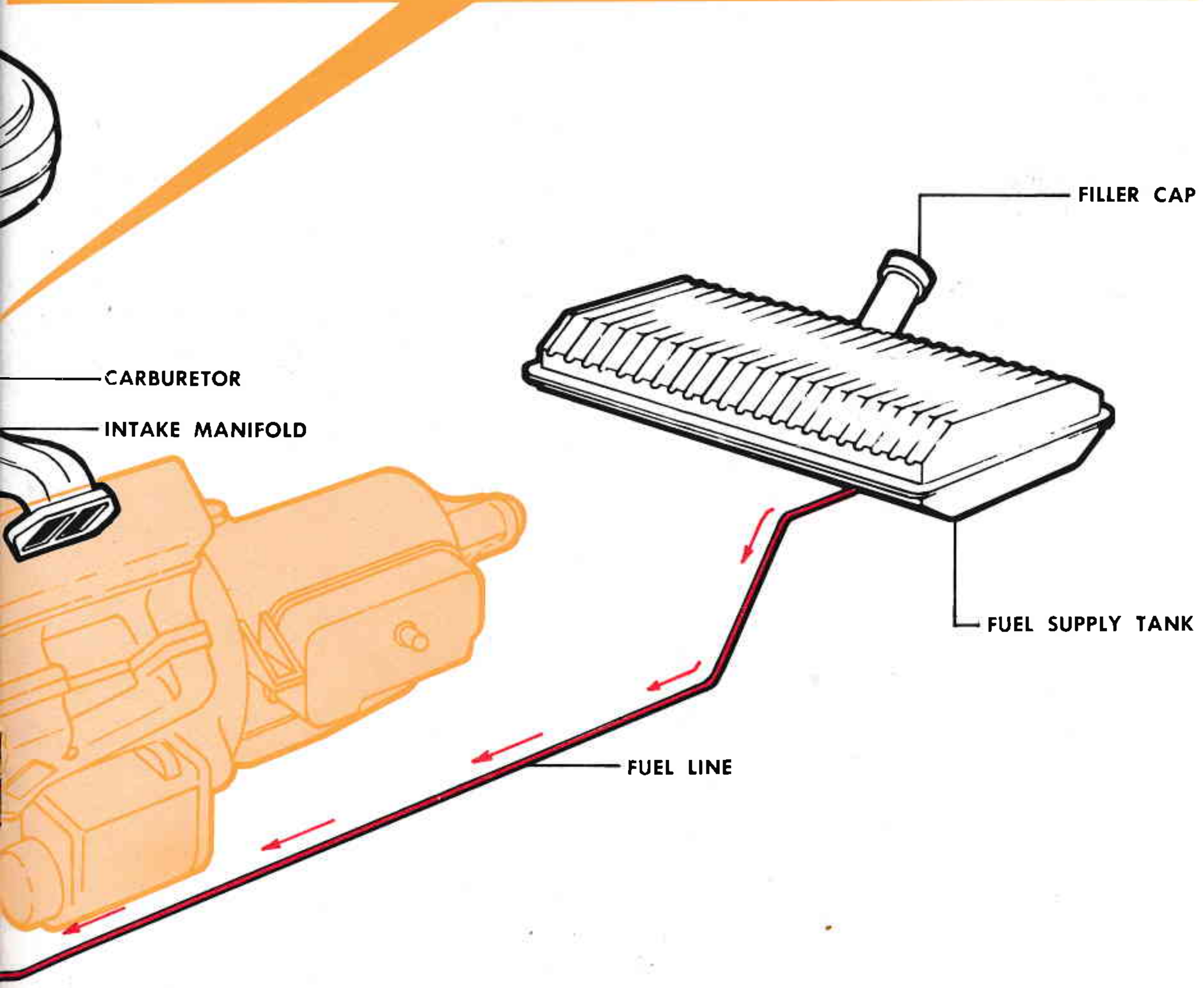
The Fuel System consists of the FUEL SUPPLY TANK, the FUEL LINES and the FUEL PUMP, the CARBURETOR and the AIR CLEANER.

Its function is to bring the gasoline from the Supply Tank to the engine and transform it into an explosive mixture by mixing it with the proper portion of air.

The CARBURETOR is the section of the fuel system where gasoline is mixed with air to form an explosive vapor. Air enters at the top of a specially designed (Venturi) tube. The moving air-stream creates a suction at the Venturi which draws fuel into the air-stream from a fuel jet strategically located in the tube. The fuel coming from the Fuel Pump enters a float chamber where the level of the fuel is kept constant by a float. This float shuts a valve when the proper fuel level is reached.

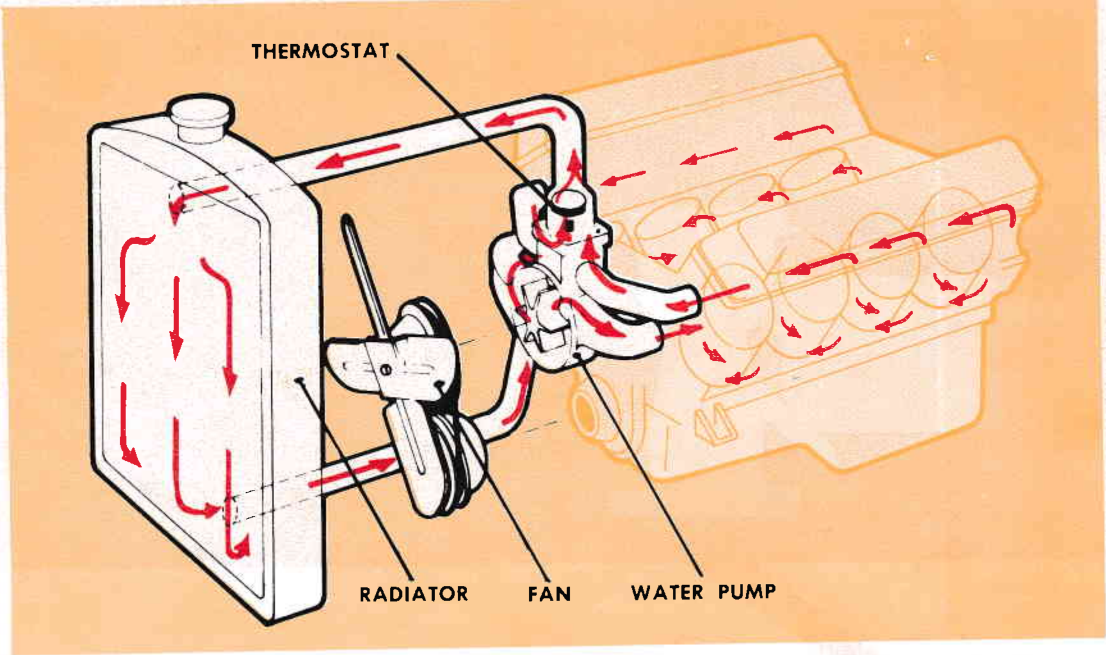


Since the proportions of the mixture of air and gasoline vary with the operating conditions of the engine, the amount of air admitted into the Carburetor must be controlled. This is achieved by the Choke Valve. When the Choke Valve is closed, very little air is admitted and the suction created by the Piston in its down stroke draws fuel from the jet. This mixture containing a large portion of fuel and a very small portion of air is called a *rich mixture;* such a mixture is required to start a cold engine. As the engine warms up, the extremely rich mixture must gradually be *leaned* until a steady air-fuel ratio of approximately 16 to 1 is reached. In modern cars, the Choke is automatic.



THE COOLING SYSTEM

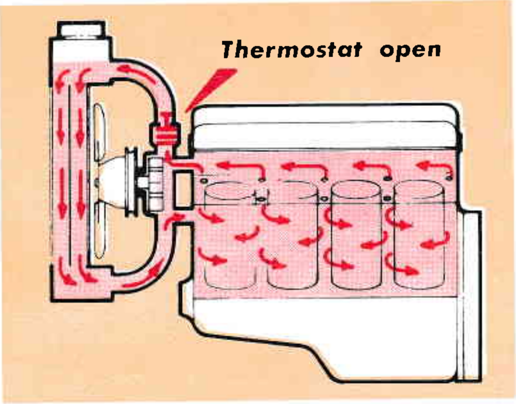
If the engines were not properly cooled the extreme high temperatures created by the exploding gas would melt many of their parts. Engines can be cooled either by air or by water. Most automobile engines are cooled by water and a Water Cooling System consists of the WATER PUMP, the THERMOSTAT, the RADIATOR and the FAN.

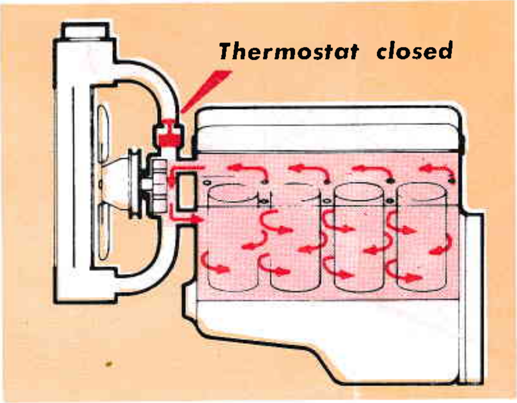


The WATER PUMP is usually of the centrifugal type, with an impeller mounted on the same shaft as the Fan and driven through a belt by the Crankshaft. Forced by the vanes of the impeller, the water is drawn from the lower tank of the Radiator and is delivered to the Cylinder Block where it cools each cylinder by circulating around its wall. From there, the coolant is pushed upward into the Cylinder Heads where it cools the combustion chambers and the valves on its way back to the Radiator.

At the front of the engine, we find a very important part of the cooling system: the THERMOSTAT. Its function is to control the operating temperature of the engine. If the water is cold, the Thermostat Bellows contract and close a valve between the Radiator and the Water Pump; the water is then circulated only within the engine proper. After the water reaches the temperature at which the Thermostat is set, the Bellows expand, opening the valve and allowing the water to circulate between the engine and the Radiator.

The RADIATOR is designed to disperse the heat which the water has taken from the engine. The core of the Radiator is constructed of long lengths of finned copper tubing. The circulating water gives up its heat to this large metallic surface, which is in turn cooled by the air being drawn through the Radiator Core by the FAN.





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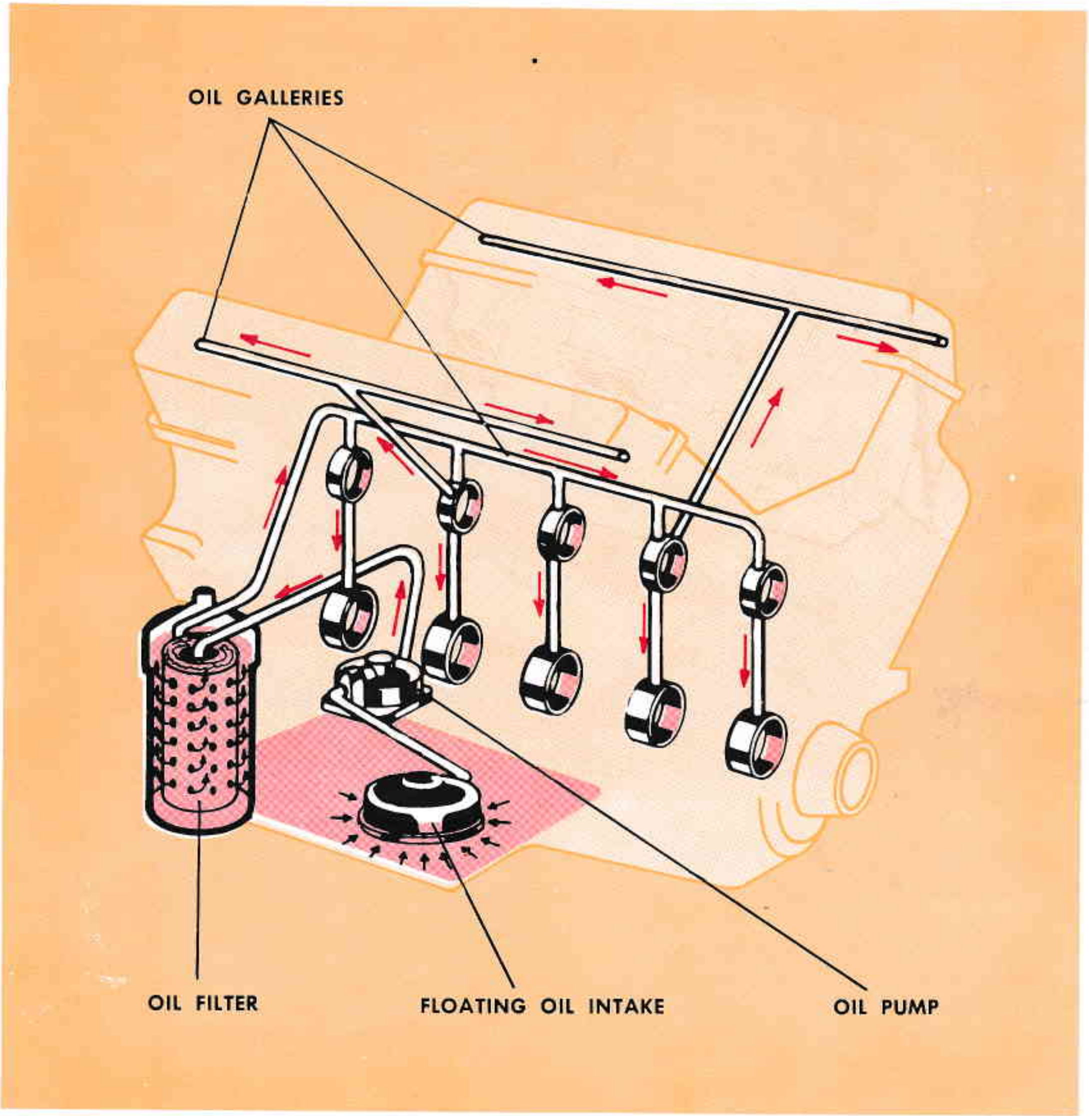
THE LUBRICATING SYSTEM

The Lubricating System is designed to apply lubricant to the moving parts of the engine in order to eliminate excessive friction which would otherwise rapidly wear them out.

The lubricant not only reduces friction, but also reduces heat created by friction, prevents power leakage between piston and cylinders, and washes away particles of worn out metal.



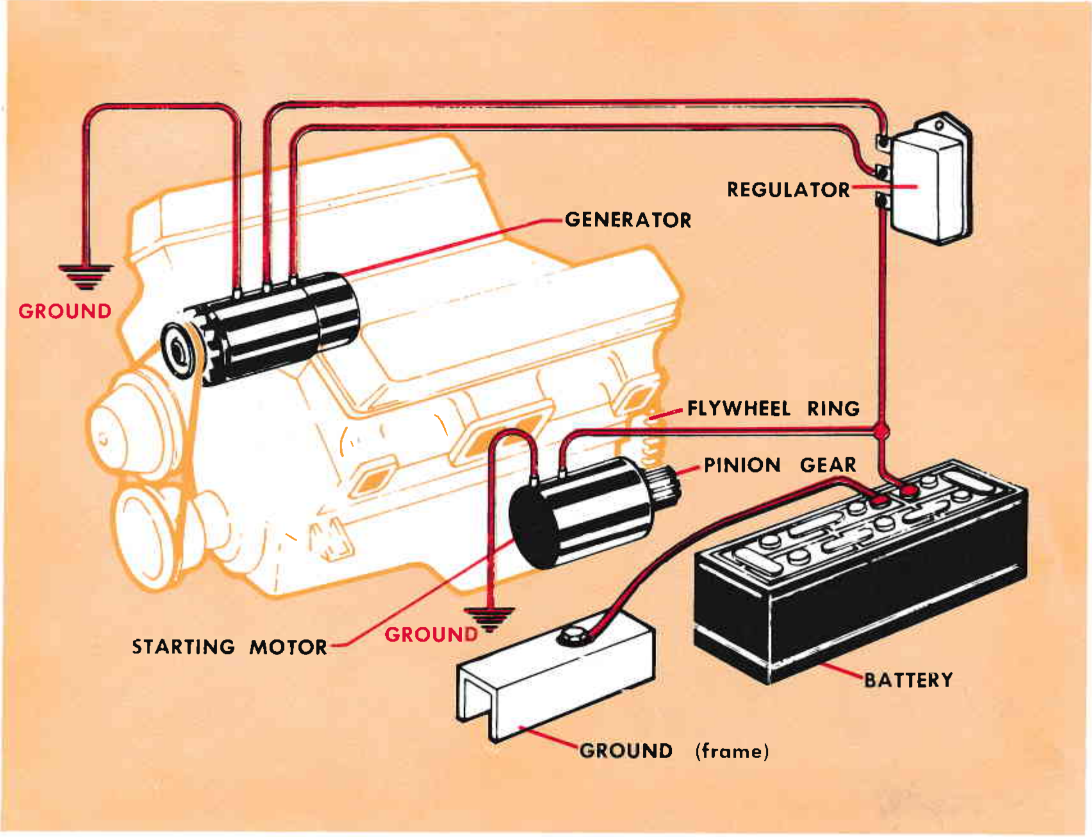
The Lubricating System consists of the FLOATING OIL INTAKE, the OIL PUMP, the OIL FILTER and the OIL GALLERIES.

The OIL PUMP, driven by the Camshaft, draws the oil from the Oil Pan through the screen of the Floating Oil Intake. This arrangement prevents any dirt, that may be deposited at the bottom of the Pan, from being drawn into the system.

The oil is further screened, as it comes out of the Pump, through the OIL FILTER. There, a replaceable element traps dirt, carbon, sand and bits of metal. Clean oil is forced through the OIL GALLERIES, which are drilled in the Block, to each individual Camshaft Bearing and, from there, to each of the Main Bearings.

The Crankshaft is drilled in such a way as to permit oil to lubricate the Connecting Rods and the cylinder walls. Additional OIL GALLERIES bring lubricant to the Rocker Arm Shafts and, from there, to each Valve Rocker and Push Rod.
Excess oil is then returned to the Oil Pan through drain holes and recirculated throughout the engine.

THE ELECTRICAL SYSTEM



The Electrical System consists of the GENERATOR, the REGULATOR, the BATTERY, the STARTING MOTOR and all the necessary wiring.

The GENERATOR converts the mechanical energy, which it obtains from the Crankshaft through a pulley and belt system, into the electrical energy needed for ignition, lights and all the various electric accessories of the modern automobile. It also recharges the Battery. The Generator consists of two basic parts: the Field Coils which create the magnetic field and the Armature Winding which rotates in the magnetic field producing a flow of current. Most of the modern Generators incorporate a cooling fan which is usually part of the driving pulley.

The REGULATOR controls the Generator's output according to the needs of the electrical system.

The BATTERY stores electrical energy for starting the engine and for operating electrical units when the output produced by the Generator is not sufficient. Its principle is to convert chemical energy into electrical energy. Batteries are built in a series of cells, each producing approximately 2 volts. A 6 volt Battery will then have 3 cells and a 12 volt Battery 6 cells, all connected in series.

The STARTING MOTOR or STARTER is a special type electric motor designed to crank the engine at a speed high enough to permit it to start. It is capable of operating under heavy overload and creates great power, but only for a short time. When the Starting Motor is operating, the driving Pinion Gear, which is attached to its shaft, is thrust forward to engage the teeth of the Flywheel. The Flywheel rotates the Crankshaft to which it is mounted thus cranking the engine. As soon as the engine starts up, the driving Pinion is automatically disengaged from the Flywheel.

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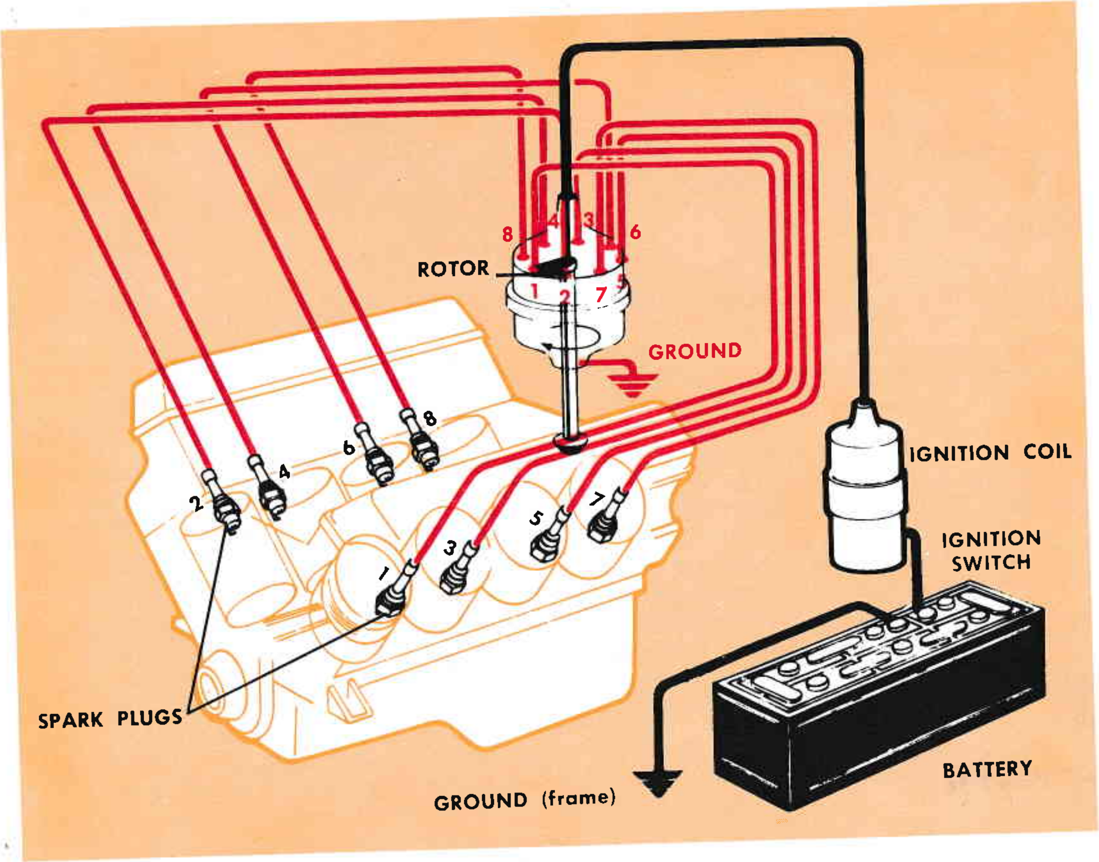


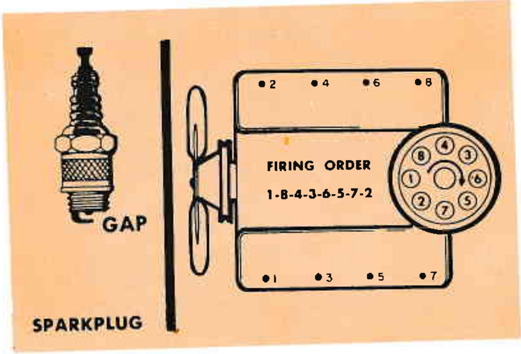
The Ignition System is designed to transform the low voltage from the Battery or Generator to the high tension voltage required to produce the sparks that ignite the compressed mixture of air and fuel in the combustion chambers.

The Ignition System consists of the IGNITION COIL, the DISTRIBUTOR, the SPARK PLUGS and high and low tension wires.

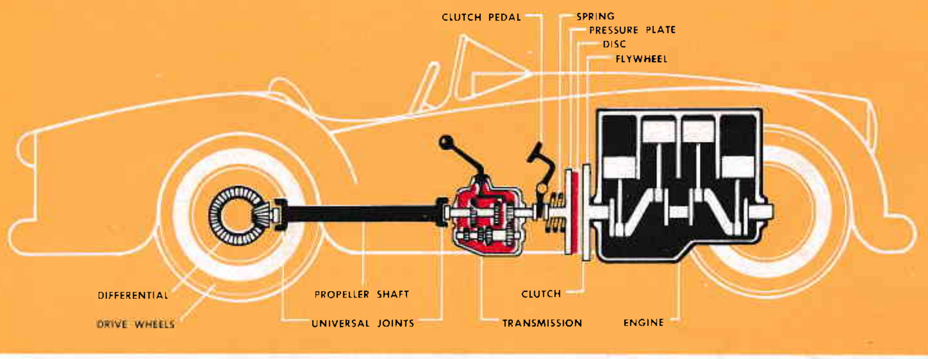
The IGNITION COIL is a transformer designed to step up the 6 or 12 volts from the Battery and Generator to approximately 20,000 volts.

The DISTRIBUTOR which is driven by the Camshaft, sends the high tension current it receives from the Ignition Coil to the proper Spark Plug at the correct instant that the corresponding piston reaches the top of the compression stroke. The high tension current enters the Distributor Cap at the center and passes to the Rotor. As the Rotor rotates within the Distributor Housing, it distributes the high tension current to each Cap Terminal in proper sequence or Firing Order.

The SPARK PLUG consists of two electrodes. The central electrode is connected to a Cap Terminal of the Distributor. The side electrode is connected to ground. The gap between the electrodes causes the current to create a spark which explodes the mixture of air and fuel.

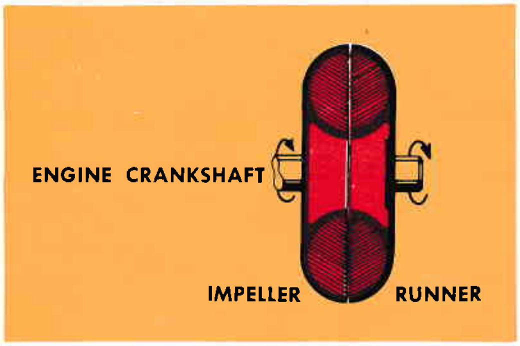


THE POWER TRAIN



The rotary motion of the engine is transferred to the driving wheels through the CLUTCH, the TRANSMISSION, the PROPELLER SHAFT, the DIFFERENTIAL.

The CLUTCH is a device designed to connect the engine to the drive wheels gently and gradually. The Clutch can be MECHANICAL or FLUID. The MECHANICAL CLUTCH consists basically of a Disc driven by the Flywheel. The Disc is held against the Flywheel by springs behind a Pressure Plate and is connected to the Clutch Output Shaft. Pressing down on the Clutch Pedal moves the Pressure Plate away from the Disc, releasing it from the Flywheel. When the Clutch is disengaged, the engine operates without transferring power to the wheels.



The FLUID CLUTCH does not have any mechanical connection between the engine and the Output Shaft. The power is transmitted from the engine to the wheels through a fluid (oil). Basically, the Fluid Clutch consists of two bowls with vanes, enclosed in a sealed unit partially filled with oil. One bowl, the Impeller, is connected to and driven by the engine. The other bowl, called the Runner, is connected to the Output Shaft. As the engine rotates, the vanes of the Impeller force the oil into motion. The motion of the oil against the vanes of the Runner causes it to rotate in the same direction, thus transferring the power from the engine to the Output Shaft.

The TRANSMISSION is designed to transform the speed and the power received from the engine into the proper driving speed and power required by the wheels. This is achieved by placing a series of matching gears on two parallel shafts, one of which is driven by the Clutch Output Shaft. By changing the sizes of the gears on either or both shafts, a wide range of combinations of speed and power can be obtained.
The Transmission (or Gear Box) can be manually operated through a lever (Gear Shift) or can be automatic. In this case, the same oil that is employed as a driving medium in the Fluid Clutch is further used to operate a series of auxiliary mechanisms that select and shift gears automatically, responding to the pressure that the driver applies to the accelerator pedal.

The PROPELLER OR DRIVE SHAFT links the Transmission with the Differential through two or more Universal Joints which allow the shaft to swing in an arc as the wheels bounce up and down on a bumpy road.

The DIFFERENTIAL consists of a series of gears designed and assembled to permit the drive wheels to turn at different speeds from one another, as for example in turning a corner, the outer wheel turns faster than the inner one.

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